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**A.C. PRECISION
MILLIVOLTMETER
VF 252**

SOLARTRON

TECHNICAL MANUAL



Instruction Manual
for
A.C. Precision Millivoltmeter
Type VF252

This manual issue is only applicable
to type VF 252 instruments with
serial numbers subsequent to, and
inclusive of, 84065

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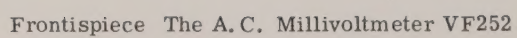
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SECTION 1

INTRODUCTION

The Precision A. C. Milli-voltmeter VF. 252 is a high-grade laboratory measuring instrument with an accuracy of 1% on all ranges and an operating bandwidth of 100 kc/s. The circuit utilises feedback amplification throughout for good gain stability, and in the meter stage the

feedback technique eliminates for all practical purposes the effects due to variations in rectifier characteristics. The mechanical design lays stress on the layout of components for cooling purposes, ease of operation and good accessibility when servicing.

SECTION 2

OPERATING INSTRUCTIONS

General

2.1 Before using the instrument ensure that the mains voltage selector panel is correctly set.

When the instrument is switched on, the feedback amplifiers take 15 - 30 secs to settle down, and the meter needle swings violently across the scale. This is quite normal and the overload is less than 100%. The violence of the needle movement is due mainly to the waveforms being applied to the meter.

Similar effects may be observed when the instrument is switched from range to range.

Connections to the A. C. Milli-voltmeter

2.2 It is recommended that one earth connection only be made from the work on test to the A. C. Milli-voltmeter, in order to eliminate the possibility of error voltage arising from loop currents. Further, when either the work or any auxiliary equipment connected to the work has a direct earth connection, the A. C. Milli-voltmeter should be set to the 47 ohms earth by means of the switch in the front panel. This connects a 47 ohms resistor between the negative earth of the instrument and the mains earth,

thus eliminating once again the possibility of a loop current.

2.3 When the equipment connected to the A. C. Milli-voltmeter is fully isolated, the above-mentioned switch should, of course, be set for direct earth. The desired input conditions can be obtained by using the appropriate input connections, i.e. two terminals for transformer input, a co-axial socket for attenuator input, and a co-axial socket for normal input, in conjunction with the input condition switch.

Operating the A. C. Milli-voltmeter

2.4 The A. C. Milli-voltmeter is extremely simple to use, and to take a voltage reading the procedure is as follows:-

- (i) Set the input condition switch to the required input condition;
- (ii) Set the range switch to a suitable range;
- (iii) Make connection to the voltage it is required to measure;
- (iv) The voltage is then indicated on the A. C. Milli-voltmeter.

SECTION 3

PERFORMANCE SPECIFICATION

General

3.1 The A. C. Milli-voltmeter has three input conditions, namely:-

Normal
Attenuator
Transformer

Signal Sensitivity Ranges

3.2 The Sensitivity ranges are 1.5mV, 5mV, 15mV, 50mV, 150mV, 500mV, 1.5V, 5V and 15V for full-scale deflection.

Nominal Frequency Range

3.3 The nominal frequency range is 10 c. p. s. to 100 K. c. p. s.

Accuracy of Indication

3.4 (i) Normal input

The indicated values on all ranges are accurate to within $\pm 1\%$ of full-scale deflection at 1 K. c. p. s. Over the frequency range 15 c. p. s. to 100 K. c. p. s. the indicated values on all ranges are within $\pm 1\%$ of full-scale deflection of the indicated values at 1 K. c. p. s. At 10 c. p. s., the indicated values on all ranges are within $\pm 0\%$ -1.5% of full-scale deflection of the indicated value at 1 K. c. p. s.

(ii) Input attenuator

The 1M-ohm input attenuator has a ratio of 10 : 1. This attenuator is adjusted to an accuracy of $\pm 0.5\%$ at 1 K. c. p. s. and is capacity compensated.

(iii) Input transformer

The useful frequency range of the input transformer is from 10 c.p.s. to 100 K.c.p.s. For details of frequency response, see frequency response curves (Figs. 1 & 2).

Input Impedance

3.5 (i) Normal input

Normal input impedance is greater than 50M-ohms, shunted by a capacitor of approximately 20pFd.

(ii) Attenuator input

The attenuator impedance is 1M-ohms.

(iii) Transformer input

The primary inductance is 50 Hy.

C.R.O. Output Volts

3.6 When the A.C. Milli-voltmeter indicates full-scale deflection, the voltage at the C.R.O. output socket is approximately 2.5V.

C.R.O. Output Signal/Noise Ratio

3.7 The noise voltage is measured at C.R.O. output socket when normal input socket is closed on a 1M-ohm resistor.

At the 15V - 15mV ranges the noise level is greater than 40db down on full-scale deflection.

On the 5mV range the noise level is greater than 35db down on full-scale deflection.

On the 1.5mV range the noise level is greater than 30db down on full-scale deflection.

Mains Requirements

3.8 This instrument is suitable for operation from 100-125V and 200-250V 50-60 c.p.s. and the consumption is 80 V A.

When the instrument is switched on, the feedback amplifiers take 15-30 secs to settle down, and the meter needle swings violently across the scale. This is quite normal and the overload is less than 100%. The violence of the needle movement is due mainly to the wave-forms being applied to the meter.

Similar effects may be observed when the instrument is switched from range to range.

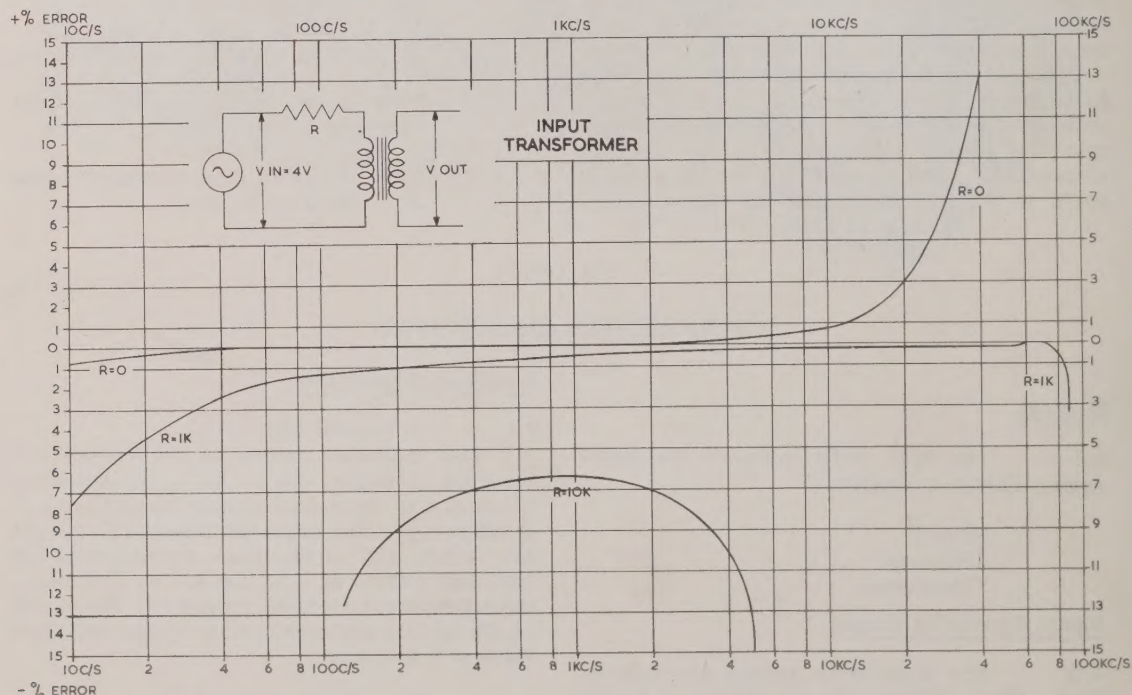


Fig. 1. Input transformer response : frequency - % error

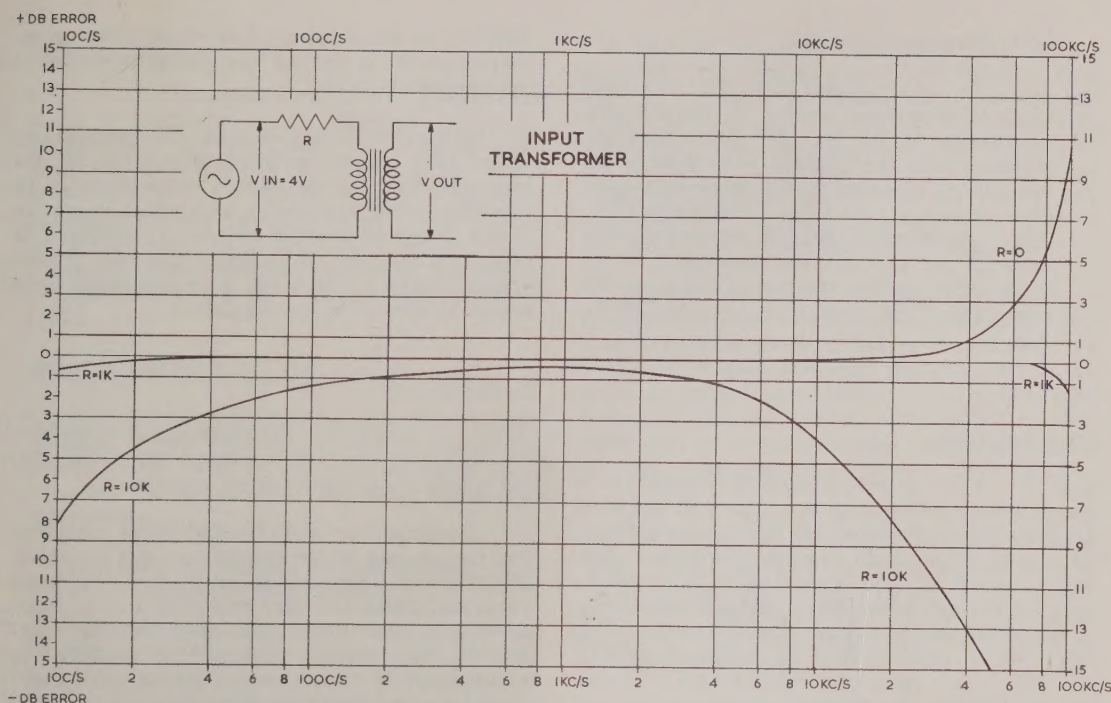


Fig. 2. Input transformer response : frequency - dB error

SECTION 4

CIRCUIT DESCRIPTION

Introduction

4.1 Basically, the A.C. Milli-voltmeter consists of four cascade connected amplifiers, incorporating negative feedback to obtain good gain stability, feeding a meter circuit. The meter circuit employs a feedback technique which, to all practical purposes, eliminates the effects of variations and non-linearities in the meter rectifying system. The sensitivity ranges of the instrument are 1.5mV, 5mV, 15mV, 50mV, 150mV, 500mV, 1.5V, 5V and 15V for full-scale deflection, and the voltage across the meter circuit for full-scale deflection is the same for all ranges. The sensitivity ranges are obtained, partly by switching the negative feedback operative on the input amplifier, and partly by means of an attenuator after the input amplifier. The usefulness of the instrument is further increased by the input condition switch, by which it is possible to select an isolated input through a 1 : 1 wide band transformer or an attenuated input through a 10 : 1 attenuator. Fig. 4 illustrates in block diagram form the various component circuits which, together, constitute the A.C. Milli-voltmeter.

Input Circuit

4.2 By means of the input condition switch,

the signal may be applied to the input amplifier by any one of the following circuits:-

(a) Normal Input

In this condition, the signal is fed via the input condition switch directly to the input amplifier; the input impedance is greater than 50M-ohms shunted by approximately 20pF.

(b) Attenuator Input

The input impedance of the attenuator is nominally 1M-ohm, and the attenuation ratio is 10 : 1.

The input attenuator consists of R89, R90, R91, RV1, C1, C2 and C29.

C1 is the D.C. isolating capacitor. The resistors (R89, R90, R91 and RV1) form a simple voltage divider. RV1 is a variable resistor used to pre-set the voltage division at low frequencies, and C2 and C29 are used to compensate for the effect of stray capacitance at high frequencies. C29 is a variable capacitor and is used to pre-set the attenuation at the high frequencies.

(c) Transformer Input

The input transformer (T1) is a wide band isolating transformer. It has primary inductance of 50 Hy., the primary being isolated from the chassis. One side of the secondary is taken to the input amplifier grid circuit via the input condition switch. This transformer has an earthed screen between the primary and secondary windings. The useful frequency range of the transformer is from 10 c.p.s. to 100 K. c.p.s.

Input Amplifier

4.3 This consists of two pentode amplifiers and a triode cathode follower, overall negative feedback being returned from the cathode follower output to the first amplifier cathode. The input circuit of this amplifier is required to operate at high impedance, and consequently, to minimise hum and microphony effects, a low microphony valve (EF86) is employed as V1. V2 (6BR7) is a valve of a similar type. V3A is one section of a 12AT7 double triode and is employed as a cathode follower. The input amplifier serves two functions: (1) to act as a buffer stage with a high input impedance and a low output impedance, (2) to provide the following voltage gains:-

- x 10 on the 1.5mV range
- x 3 on the 5mV range
- x 1 on all other ranges

The input resistance on the 1.5mV range is approximately 50M-ohms, indicating a gain of 20db operative around the feedback loop. On other ranges, loop gain is correspondingly higher. To provide the gain required on each range, the range attenuator also acts as a feedback attenuator for the input amplifier. This feedback attenuator is compensated by a pre-set capacitor C30. Additional compensation is provided in the 5mV range by C33. C4 across R3 and C25 in series with R9 between V2 anode and H.T. negative combine to prevent parasitic oscillations, by reducing the rate of phase lag with frequency.

To reduce hum and noise a resistor R98 is connected in series with V1 heater.

Range Attenuator

4.4 The range attenuator comprises R15, R16, R17, R18, R19, R20, R21, R22 and R23. It is a simple ladder attenuator and its input resistance is nominally 21,444 ohms. It has nine positions. On the first three positions, corresponding to the 1.5mV, 5mV and 15mV

ranges, no attenuation takes place. The attenuation per step for the remaining positions is approximately 10db.

On the first three positions, the range attenuator acts as the feedback attenuator for the input amplifier, the necessary connections being made by a separate switch bank which is ganged to the range attenuator switch. Capacitor C31 compensates the attenuator against "break across" when a high level, high frequency input signal is applied to the amplifier.

Amplifier (A)

4.5 Amplifier (A) consists of a double-triode valve (V4) and a pentode valve (V5), together with their associated components.

The amplifier is of a feedback type, employing two stages of amplification, and a cathode follower with overall negative feedback returned from the cathode follower output via a fixed feedback attenuator to the cathode of the first amplifier. The voltage gain of this amplifier is approximately 15.5 times. The negative feedback operative round the circuit is approximately 21.5db.

Capacitor C26 in series with R93, connected from the anode of V4A to the H.T. negative rail and C28 connected across R35 in the cathode circuit of V4B, are to prevent high frequency parasitic oscillations. The capacitor C10 (coupling V5 to V4B) has a resistor (R32) connected in parallel. Its action is to reduce the overall phase advance of the circuit at low frequencies, and thus preserve good "damping".

Amplifier (B)

4.6 Amplifier (B) consists of a double triode valve (V6) and a pentode valve (V7), together with their associated components.

This amplifier is constructed along the same lines as Amplifier (A), the only difference being in the negative feedback attenuator which, in this case, contains a variable element.

In order that all sensitivity ranges of the A.C. Milli-voltmeter may be set precisely, each range has been fitted with a separate gain control potentiometer. These potentiometers are numbered RV3 to RV11 inclusive. They are connected in the negative feedback attenuator by means of a switch which is ganged to the range attenuator switch. When a range is selected, the appropriate potentiometer is connected in parallel with R76. The voltage gain of this stage is nominally 13.5 times. The negative feedback operative is approximately 22.5db.

C. R. O. Output

4.7 To facilitate monitoring the measured signal by a cathode ray oscilloscope, a C. R. O. output socket is provided. The output from Amplifier(B) is taken to the grid of V12B, which is one section of a double triode. This valve is connected as a cathode follower, and its output is fed via C15 to the C. R. O. socket. For full-scale deflection on the meter, the output voltage at this C. R. O. socket is approximately 2.5V.

Output Amplifier and Meter Circuit

4.8 The output amplifier and meter circuit consists of two pentode valves (V8 and V9), a double triode valve (V10), a double diode valve (V11) and the meter (M1), with their associated components.

This amplifier has two stages of amplification and has a cathode follower output.

The metering circuit is connected between the cathode of the cathode follower and the +50V rail. Direct coupling is used for this connection and, consequently, the quiescent potential of the cathode is arranged to be at +50V. The output from the cathode follower is fed to the double diode (V11), which is connected as a full wave rectifier for the meter (M1). When the output voltage overcomes the diode standing bias (which is approximately 2V), current flows through the diode.

The action for each half of the current is now considered. The current flows through the conducting half of the double diode and then divides through a parallel network. One branch of this network consists of the meter (M1) in series with a 1.5K-ohm resistor; the other branch of the network consists of a 1.5K-ohm resistor.

Since the resistance of the meter is negligible by comparison to 1.5K-ohms, the currents flowing through the two branches are considered equal. After passing through this parallel network, the two currents combine to flow through R53 and R54 and then to the 50V rail. The voltage produced across R54 is fed back to the cathode of V8 and provides overall negative feedback for the output amplifier and metering circuit. The voltage produced by the current through R53 and R54 is fed back to the screen grid of V8, its action being to provide decoupling for this screen grid. To maintain good damping at very low frequencies, the capacitor C17 coupling V9 and V10 has R64 connected in parallel. This resistor, in conjunction with the grid leak (R63), transfers a portion of the quiescent anode potential of V9 to the control grid of V10.

In order that the D. C. cathode potential of

V10 shall be held at approximately +50V D. C., feedback is employed round V9 and V10. This negative feedback is obtained by connecting the cathode of V10 back to the grid (V9), via V9 grid leak (R68). The capacitor C16, connected from the cathode of V10, gives a measure of phase advance at very high frequencies and thus damps the amplifier at such frequencies. This reduces the susceptibility to parasitic oscillations.

Before the signal voltage applied to the meter diodes reaches the amplitude (2V peak) necessary to overcome the standing bias, no overall negative feedback is operative, and the open gain of the amplifier is realised. This gain can be assessed by measuring the input to the output amplifier necessary to bring about the inception of diode current. This was found to be 11.2mV (peak).

Now the diode bias is 2V; therefore, the open gain of the output amplifier is approximately 45db. When feedback is operative, the gain of the output amplifier is approximately 7db; therefore, the negative feedback around the output amplifier when the diodes are conducting is approximately 38db.

Due to the standing bias on V11 when there is no input to the millivoltmeter there is a very small residual indication on M1 of between $\frac{1}{2}$ and 1% of F. S. D. The effect of this error decreases with increases of meter reading.

Power Supplies

4.9 The main H. T. rail of the A. C. Millivoltmeter is supplied from a Solartron Power Supply Sub-unit 250V/50mA, AS952.2. This gives an H. T. line of high stability, low output impedance, and low hum and noise level.

The stabilisation factor of the Power Supply Sub-unit AS952.2 is approximately 1,000 : 1; consequently, a mains surge of 5 volts produces an H. T. surge in the order of 5mV. In view of the high sensitivity of the A. C. Milli-voltmeter, the H. T. supply to the input amplifier must be devoid of even surges as small as 1mV in amplitude. To ensure that the H. T. supply to this input amplifier meets this stringent requirement, it is fed via a surge filter circuit.

This filter circuit consists of two main parts. The first part of the surge filter is an R. C. filter comprised of R13, R14 and C7. This provides a surge-free output of approximately 180V, but at a high output impedance. To ensure good decoupling of the 180V H. T. rail supplying the input amplifier, a low source impedance is required. To obtain this, the second part of the surge filter is used. Basically, it is one section of a double triode (V3A), connected as a cathode follower, whose input is the surge-free 180V obtained as mentioned above. Therefore, the

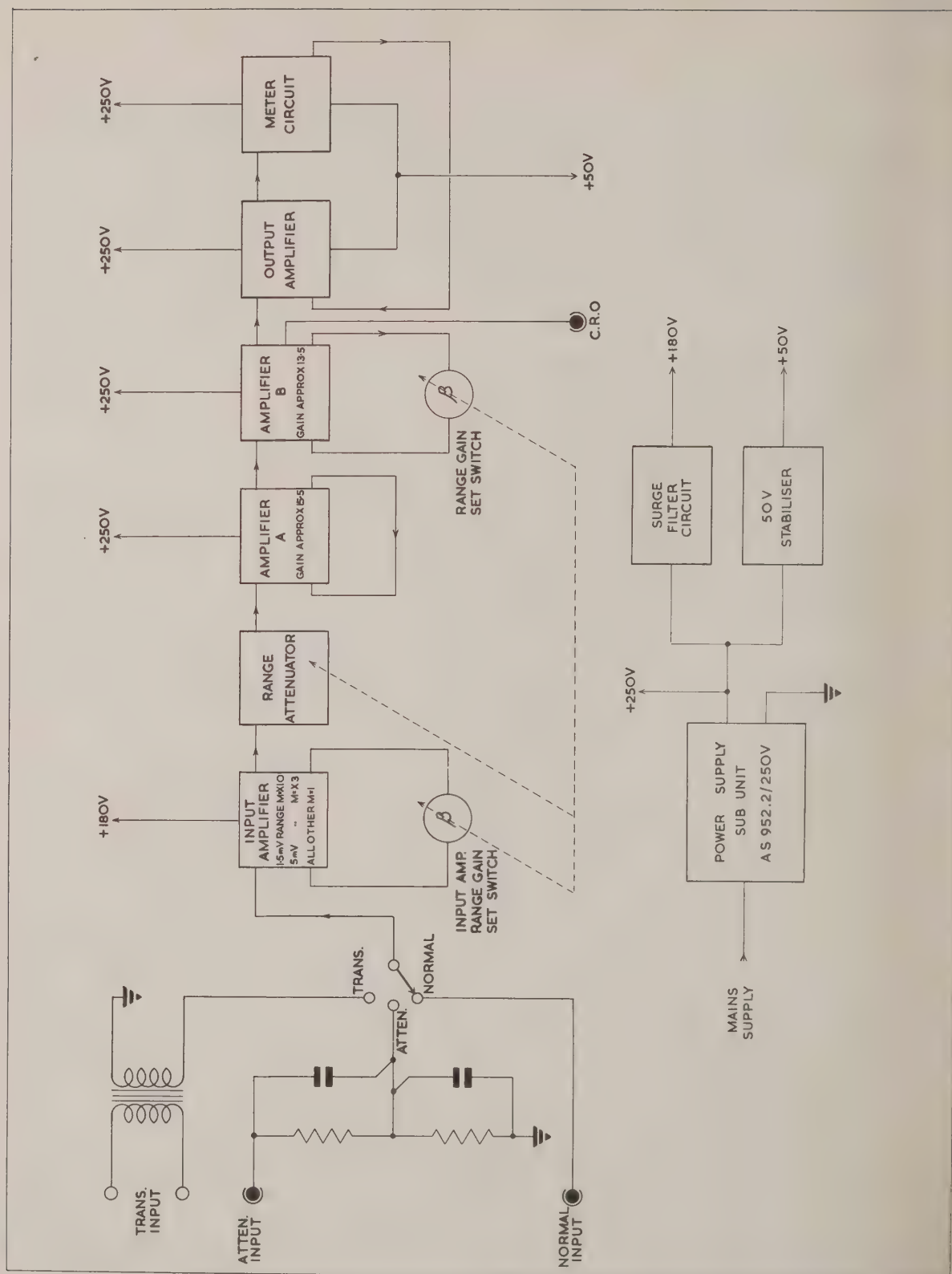


Fig. 3. The A. C. Millivoltmeter : block diagram

output from its cathode is the surge-free 180V at a low source impedance. As V3A cannot deal with the entire current required by the input amplifier, some current is fed directly from the 250V rail via R12.

The 50V rail is obtained by means of a stabiliser system, operating from the 250V rail. It comprises a double triode valve (V13) and one section of a double triode valve (V12A), together with their associated components.

The system employed is very similar to a conventional hard valve stabiliser, but it uses two stages of amplification within the control loop, in place of the usual single stage.

The 50V rail is obtained from the cathode of the series stabilising valve (V12A). The two sections of V13 form the two-stage amplifier. The overall feedback is obtained by directly

coupling the cathode of the series stabilising valve (V12A) to the cathode of the first amplifier valve (V13A).

The reference voltage applied to the grid of V13A is obtained from a voltage divider network connected across the 250V rail. The variable resistor (RV12) permits precise adjustment of the rail voltage to the desired value of 50V. The source impedance of the 50V rail rises at high frequencies when the gain of the control loop falls due to its comparatively narrow bandwidth. A capacitor (C14), in series with R39, is connected from the cathode of V12A to the H. T. negative rail. The purpose of this capacitor is to produce a low source impedance at high frequencies. The resistor R39, in series with C14, prevents peaking of the source impedance at the frequency where the capacitor effectively takes over from the stabiliser circuit.

SECTION 5

SETTING UP PROCEDURE

Test Gear Required

- a) An oscillator to cover the frequency range 25 c/s to 100 kc/s capable of delivering 20 mA at 10V into a resistive or inductive load with continuously variable amplitude control, e.g. Solartron CO 546.
- b) An oscillator to cover the frequency range 15 c/s to 1 kc/s with continuously variable amplitude control (capable of being standardised to an accuracy of 0.25%) e.g. Solartron OS 103.2.
- c) Kelvin Varley divider box, 10 k Ω resistance, four dial, 0.1% grade, e.g. H.W. Sullivan High Frequency Decade Potentiometer.
- d) A cathode-ray oscilloscope with sensitivity of between 1 and 3 volts/cm at 1 kc/s, e.g. Solartron CD 1014.2.
- e) An Avo-meter model 8.
- f) A capacity measuring instrument, e.g. Solartron MM 906.
- g) A means of standardising a ten volt r.m.s. undistorted signal to an accuracy of 0.25% over the frequency range 25 c/s to 100 kc/s. The method described in this handbook requires Cambridge Test Set, A decade resistor box set to 289.9 Ω , frequency standard, a thermocouple voltmeter and a Solartron AC Millivoltmeter VF 252. The method of standardising voltage is described in an appendix to this section.

Preliminary Setting-Up

Before switching on the instrument under test, adjust the mechanical zero of the meter for zero indication. Switch on all test equipment and allow 30 minutes to warm up. Switch on the instrument under test, and allow to warm up for at least 5 minutes. Use the Avometer model 8 to measure the HT voltage supplied by the power supply sub-unit AS 952.2. Adjust RV1 on the power supply sub-unit to set this voltage to 250V.

Measure the voltage across R49. Adjust RV12 until this voltage is 50V. Connect a shielded 1 megohm resistor across the NORMAL input socket. Set the range switch to 1.5mV and select NORMAL input. Adjust RV2 to obtain minimum indication of the meter. This should be less than 1 division on the outer scale.

Setting-Up of Range Sensitivities

Connect the test gear together as shown in Fig. 4A. Set the oscillator output to 10V within 0.2% at 1 kc/s using the procedure described in the appendix. The instrument under test should be connected for NORMAL use.

Set the range of VF 252 and the Kelvin Varley potentiometer as shown in the following table, using the adjustment shown to obtain the indication required.

K. V. Pot ^r .	VF252 Range	Adjust VF252 Pot ^r .	Indication Required
9,9,9,10	15V	RV11	10.0 Inner Scale
4,0,0,0,	5V	RV10	4.0 Outer Scale
1,2,0,0,	1.5V	RV 9	4.0 Outer Scale
0,4,0,0,	500mV	RV 8	4.0 Outer Scale
0,1,2,0,	150mV	RV 7	4.0 Outer Scale
0,0,4,0,	50mV	RV 6	4.0 Outer Scale
0,0,1,2,	15mV	RV 5	4.0 Outer Scale
0,0,0,4,	5mV	RV 4	4.0 Outer Scale
0,0,0,1,	1.5mV	RV 3	10.0 Inner Scale

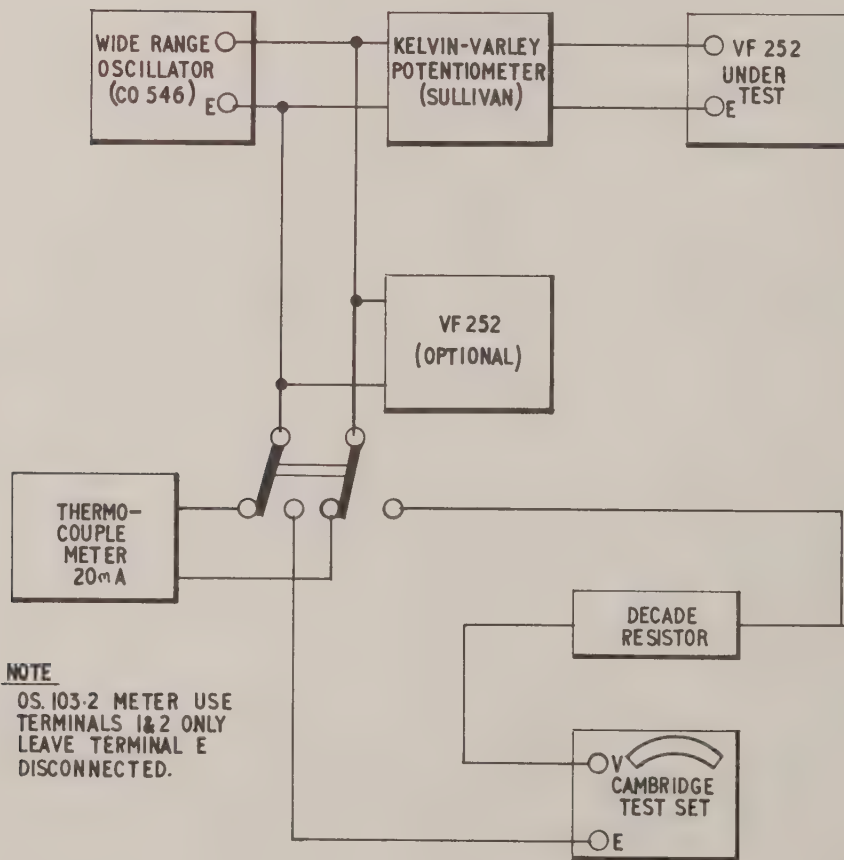


Fig. 4a. Arrangement of Test Gear for Calibration.

10 : 1 Attenuator Adjustment

Set the oscillator to 10V at 1 kc/s as described in the appendix and connect the test gear as in Fig. 4A. Set the Kelvin Varley potentiometer to 9,9,9,10 with the VF252 on NORMAL and the 15V range setting, the indication on the inner scale should be 10. Reset the VF252 for 10 : 1 attenuation by adjusting the input selector switch and connecting the signal to the 10 : 1 attenuator input. Set the range switch to 1.5V and adjust RV1 to give an indication of 10 on the inner scale.

HF Setting-Up

With the test gear connected as in Fig. 4A, set the oscillator to deliver 10V at 1 kc/s and the Kelvin Varley potentiometer to 9,9,9,10. Set the VF 252 for 10 : 1 attenuation with the range switch set to 1.5V. The indication on the VF 252 should be 10 on the inner scale.

Increase the oscillator frequency to 100 kc/s $\pm$ 2% and set its output voltage to 10.0 using the thermocouple meter as a transfer standard. Adjust C29 on the VF252 until the indication is again 10 on the inner scale.

Reset Kelvin Varley potentiometer to 0,0,0,1 and set the VF 252 for NORMAL input on the 1.5mV range. Adjust C30 to obtain an indication of 10 on the inner scale. Reset the Kelvin Varley Potentiometer to 0,0,0,4 and the VF 252 range to 5 mV. Adjust C33 on the VF252 to obtain an indication of 4V on the outer scale. Should it be impossible to accomplish this, it may be necessary to modify the values of the fixed capacitors C26, C32 and C20. If this is done the HF adjustment of the instrument must be rechecked as above.

Using the test equipment connected as in Fig. 4A obtain an indication of 4 on the outer scale of the VF 252 under test, at one 1 kc/s, on any range. Insert a jack plug, closed by 1000 Ω , into the jack socket when the indication should change by less than 1%.

PERFORMANCE TESTS

Calibration Accuracy

Using the test gear connected up as in Fig. 4A, set-up the various signal levels tabulated in the setting-up procedure and check the accuracy of the instrument under test at 15 c/s and 100 kc/s, on all ranges. The thermocouple meter will have to be used as a transfer standard of voltage for the higher frequencies, and the meter in the low frequency oscillator OS103.2 will have to be used as the standard transfer of voltage at the lower frequencies. The accuracy of the VF252 under test must be at least $\pm$ 1% on all ranges and at both frequencies, i.e. one half of one outer scale division.

Scaling Accuracy

With the test gear still connected as shown in Fig. 1, set the VF252 to give full scale deflection at 1 kc/s on the 5V range with the Kelvin Varley potentiometer set to 5,0,0,0. Check the accuracy of indication at the following settings of the Kelvin Varley potentiometer: 5,0,0,0; 4,0,0,0; 3,0,0,0; 2,0,0,0; 1,0,0,0, and 0,5,0,0. The error on the instrument under test should be less than one half of one outer scale division.

Mains Variation

Return the Kelvin Varley potentiometer to 4,0,0,0, and check that the indication on the instrument under test is 4 on the outer scale. Change the mains input voltage $\pm$ 7% about the nominal value and hold it at each extreme for 2 minutes. The change in indication should be less than 1% from the setting at nominal mains voltage.

C.R.O. Socket

Reset the mains to nominal and adjust the Kelvin Varley potentiometer to 5, 0, 0, 0. Check that the VF252 shows full scale deflection. Measure the amplitude of the waveform at the cathode ray oscilloscope socket, using an oscilloscope. The waveform should be sinusoidal and its amplitude should be 7V peak-to-peak ± 0.5 V.

Transformer Input

Connect the instrument under test to the wide range oscillator CO 546 using the transformer input terminals on the 15V range, and connect a 1000 Ω 5% resistor in series with the signal lead. Set the oscillator output to 10V exactly and the frequency specified in the following table, using the thermocouple meter as a transfer standard of voltage.

Frequency	Indication - Volts
1 kc/s	10.0 $\pm$ 0.2
25c/s	9.75 $\pm$ 0.25
50 kc/s	10.0 $\pm$ 1.1

Input Capacitance

Measure the input capacitance at the normal input socket with the input condition switch set to NORMAL. The value obtained should not exceed 25 pFd.

APPENDIX

Voltage Standardisation

Connect the decade resistor box in series with the voltage terminals of the Cambridge test set as shown in Fig. 4B. Set the test set to 20 mA. Connect AC millivoltmeter type VF 252 across the decade box and Cambridge test set. Connect the oscillator as shown in Fig. 4B making sure that the test set earth terminal is at earth.

Set the oscillator frequency to exactly 1 kc/s. Increase the oscillator voltage until full scale deflection is obtained on the Cambridge test set. Note the indication of the VF 252 which should be set on the 15V range with NORMAL input. The VF 252 may either be calibrated to give 10V indication or the actual indication can be recorded.

Disconnect the decade box and test set from the oscillator and replace these by the thermocouple meter. Set the oscillator voltage so that the VF 252 indication is the same as that obtained previously. Either set the thermocouple meter sensitivity to give exactly ten volts indication or record its indication, which should be near 10V.

The thermocouple meter now connected permanently across the oscillator output terminals, may be used over the frequency range 25 c/s to 100 kc/s, and the accuracy over this range may be relied upon to within $\pm 0.1\%$ with respect to r.m.s. values.

Connect the oscillator and the test set to the VF 252 and obtain the standard 10V signal as described before. Note the indication of VF 252. Connect the VF 252 to the 0⁰ and earth outputs of the low frequency decade oscillator OS 103.2. Set to 100, 0, 0 x 10 (1 kc/s), and adjust the OS 103.2 output to obtain the standardised indication on the VF 252, corresponding to 10V. Note the OS 103.2 oscillator meter indication, this indication may be used to obtain 10V $\pm$ 0.2% over the frequency range 10 c/s to 1 kc/s provided that only the decade switches are used to adjust frequency. The multiplier should remain at the x 10 setting.

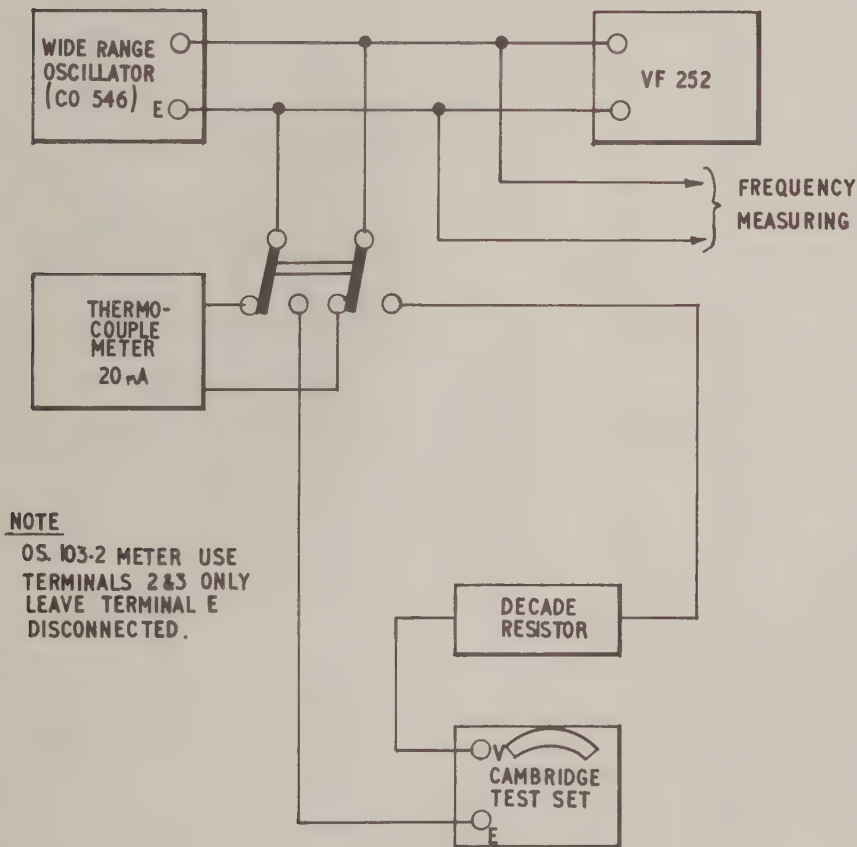


Fig. 4b. Arrangement of Test Gear for DC Standardisation.

SECTION 6

QUIESCENT LEVELS

General	Testing	+ Lead	Meter Range	Indication
6.1	These D.C. levels are provided for guidance only during fault finding, and should not be taken as mandatory requirements.			
	V1 anode	V1/6	250V	135V
	V1 screen	V1/8	250V	135V
	V1 cathode	V1/1	100V	80V
	V2 anode	V2/7	250V	74V
	V2 screen	V2/8	250V	72V
	V2 cathode	V2/3	10V	1.85V
	V3a anode	V3/1	250V	181V
	V3a cathode	V3/3	250V	75V
	V3b anode	V3/6	250V	250V
(i)	V3b cathode	V3/8	250V	181V
(ii)	V4a anode	V4/6	250V	143V *
	V4a cathode	V4/8	10V	1.95V
	V4b anode	V4/2	250V	250V
(iii)	V4b cathode	V4/3	100V	18V
	V5 anode	V5/5	250V	212V
	V5 screen	V5/7	250V	60V
	V5 cathode	V5/2	2.5V	.45V
	V6a anode	V6/6	250V	250V
	V6a cathode	V6/8	10V	2.1V
(iv)	V6b anode	V6/1	250V	250V
(v)	V6b cathode	V6/3	100V	17V
	V7 anode	V7/5	250V	188V
	V7 screen	V7/7	250V	81V
6.2	V7 cathode	V7/2	2.5V	.77V
	V8 anode	V8/5	250V	232V
	V8 screen	V8/7	250V	100V
	V8 cathode	V8/2	250V	50V
	V9 anode	V9/5	250V	215V
	V9 screen	V9/7	250V	121V
	V9 cathode	V9/2	250V	50V
	V10a anode	V10/6	250V	250V
	V10a cathode	V10/8	100V	49V
	V10b anode	V10/1	250V	250V
	V10b cathode	V10/3	100V	49V
	V11a anode	V11/7	100V	48.5V
	V11a cathode	V11/1	100V	50.6V
	V11b anode	V11/2	100V	46.8V
	V11b cathode	V11/5	100V	48.7V
	V12a anode	V12/1	250V	250V
	V12a cathode	V12/3	100V	21V
	V12b anode	V12/6	250V	250V
	V12b cathode	V12/8	250V	50V
	V13a anode	V13/6	250V	97V
	V13a cathode	V13/8	100V	50V
	V13b anode	V13/1	250V	95V
	V13b cathode	V13/3	100V	47.5V

* 33K-ohms in series with Avometer to prevent parasitic oscillation.

6.3 H. T. Current: 52 M. A.
 Main Consumption: 77 V. A.

FAULTS CHART VF. 252

SYMPTOM	POSSIBLE CAUSE	REMEDY
Complete failure	Fuse blown Mains transformer faulty. A. C. input wiring faulty.	Replace the fuse. Check the insulation and continuity of the transformer windings. Check the circuit wiring from the mains plug to the transformer primary winding.
No meter reading on all ranges.	No high-tension voltage, fault in the amplifier chain.	Check high-tension voltage. Check the amplifier by reference to the D. C. and signal voltage charts. Check valves and components in faulty section. Check the external meter socket and wiring. N. B. (when the jack is fitted to the socket, the internal meter is open circuited).
Meter reading hard over on all ranges.	Faulty high-tension supply. Fault in the feedback circuits of the amplifier chain.	Change valves in high-tension regulation circuit. Check amplifier as before.
No high-tension voltage	Power supply sub-unit faulty.	Check valves and circuit components in power sub-unit.
Incorrect voltage on 50-volt line.	V12, V13 or associated circuitry.	Change V12, V13. Check circuit components. Adjust RV12 for slight errors.
Low meter reading all ranges.	Faulty amplifier.	Check the amplifier as before.
Incorrect reading on any one range.	Faulty attenuator switching. Faulty range adjustment, potentiometer.	Check the attenuator switch. Check the relevant potentiometer (RV3 to RV11).
Slight error on any one range.	Mal-adjustment.	Adjust the relevant potentiometer (RV3 to RV11).
Poor low-frequency response.	V3 faulty C6 faulty	Change V3. Change C6.
Poor high-frequency response on normal input.	C30	Readjust C30 at 100 Kc/s, as in "H. F. setting up" para. of the handbook.
Poor high-frequency response on attenuator input.	C29	Readjust C29 at 100 Kc/s as in "H. F. setting up" para. of the handbook.
No response from the attenuator input.	C1, R89, RV1 open circuit.	Check or replace these components.
Poor response from the attenuator input.	C1, C2, R89, R90, RV1, C29.	Check or replace these components.
No response from the transformer input.	T1	Check T1.
Incorrect or no output from "C. R. O. " socket.	V12 or associated circuitry.	Change V12. Check circuit components.
Continuous oscillation on meter all ranges.	Faulty N78 in power sub-unit. Wrong adjustment of mains tapping panel.	Change N78. Check supply voltage and adjust mains tapping panel.

SIGNAL VOLTAGE CHECK POINTS

Inject sufficient amplitude of signal at 1 Kc/s to give full-scale deflection under normal conditions for the range selected. (Example: 15 mV on 15 mV range). Measure the voltage with a VF.252 at the following points.

TEST POINT		VOLTAGE
V3 pin 3		Input x 10 on 1.5 mV range Input x 3 on 5 mV range Input x 1 on all other ranges
V4 pin 2	12 m Volts	
V6 pin 2	200 m Volts	
V8 pin 1	2.85 Volts	
V8 pin 5	1.1 Volts	
V9 pin 5	12.5 Volts	
V10 pin 8	12.5 Volts	

SECTION 7

COMPONENTS LIST

Circuit Ref.	Value Ohms	Tol. %	Rating Watts	Solartron Part No.	Manufacturer & Type	
RESISTORS						
R1	4.7M	10	$\frac{1}{4}$	1723 64700	Erie	16 Carbon
R2	100K	5	$\frac{1}{4}$	1705 51000	Painton	92 H.S.
R3	4700	5	1/8	1702 34700	Erie	109 H.S.
R4	2.2M	10	$\frac{1}{4}$	1723 62200	Erie	16 Carbon
R5	39K	5	$\frac{1}{2}$	1708 43900	Painton	93 H.S.
R6	33K	5	$\frac{1}{2}$	1708 43300	Painton	93 H.S.
R7	47K	5	$\frac{1}{4}$	1708 44700	Painton	92 H.S.
R8	360	5	1/8	1702 23600	Erie	109 H.S.
R9	1000	10	$\frac{1}{4}$	1723 31000	Erie	16 Carbon
R10	22	10	$\frac{1}{4}$	1723 12200	Erie	16 Carbon
R11	22	10	$\frac{1}{4}$	1723 12200	Erie	16 Carbon
R12	12K	5	2	1930 41200	Welwyn	F32. OF
R13	680K	1	$\frac{1}{2}$	1707 56800	S. T. C.	4304 H.S.
R14	1.8M	1	$\frac{1}{2}$	1710 61800	Painton	74 H.S.
R15	30K	1	$\frac{1}{4}$	1704 43000		
R16	30K	1	$\frac{1}{4}$	1704 43000		
R17	4300	1	1/8	1701 34300	Erie	109 H.S.
R18	1500	1	1/8	1701 31500	Erie	109 H.S.
R19	430	1	1/8	1701 24300	Erie	109 H.S.
R20	150	1	1/8	1701 21500	Erie	109 H.S.
R21	43	1	$\frac{1}{2}$	1707 14300	S. T. C.	4304 H.S.
R22	43	1	$\frac{1}{2}$	1707 14300	S. T. C.	4304 H.S.
R23	43	1	$\frac{1}{2}$	1707 14300	S. T. C.	4304 H.S.
R24	4700	10	$\frac{1}{4}$	1723 34700	Erie	16 Carbon
R25	1M	10	$\frac{1}{4}$	1723 61000	Erie	16 Carbon
R26	47K	5	$\frac{1}{2}$	1708 44700	Painton	93 H.S.
R27	1M	10	$\frac{1}{4}$	1723 61000	Erie	16 Carbon
R28	150K	10	$\frac{1}{4}$	1723 51500	Erie	16 Carbon
R29	56K	10	$\frac{1}{4}$	1723 45600	Erie	16 Carbon
R30	33K	10	$\frac{1}{4}$	1723 43300	Erie	16 Carbon
R31	330	10	$\frac{1}{4}$	1723 23300	Erie	16 Carbon
R32	6.8M	10	$\frac{1}{4}$	1723 66800	Erie	16 Carbon
R33	470K	10	$\frac{1}{4}$	1723 54700	Erie	16 Carbon
R34	22	10	$\frac{1}{4}$	1723 12200	Erie	16 Carbon
R35	5100	1	1	1964 35100	Welwyn	Welmet M. F.
R36	360	1	1	1964 23600	Welwyn	Welmet M. F.
R37	1M	5	$\frac{1}{2}$	1708 61000	S. T. C.	4304 H.S.
R38	200K	5	1/8	1702 52000	Erie	109 H.S.
R39	22	10	$\frac{1}{4}$	1723 12200	Erie	16 Carbon
R40	470K	10	$\frac{1}{4}$	1723 54700	Erie	16 Carbon
R41	1M	10	$\frac{1}{4}$	1723 61000	Erie	16 Carbon
R42	1M	10	$\frac{1}{4}$	1723 61000	Erie	16 Carbon
R43	470K	10	$\frac{1}{4}$	1723 54700	Erie	16 Carbon
R44	56K	10	$\frac{1}{4}$	1723 45600	Erie	16 Carbon
R45	1M	10	$\frac{1}{4}$	1723 61000	Erie	16 Carbon
R46	1M	10	$\frac{1}{4}$	1723 61000	Erie	16 Carbon
R47	330K	10	$\frac{1}{4}$	1723 53300	Erie	16 Carbon
R48	22	10	$\frac{1}{4}$	1723 12200	Erie	16 Carbon
R49	6800	10	$\frac{1}{4}$	1723 36800	Erie	16 Carbon
R50	10	10	$\frac{1}{4}$	1723 11000	Erie	16 Carbon

Circuit Ref.	Value Ohms	Tol. %	Rating Watts	Solartron Part No.	Manufacturer & Type	
RESISTORS (Contd.)						
R51	1500	1	1/8	1701 31500	Erie	109 H. S.
R52	1500	1	1/8	1701 31500	Erie	109 H. S.
R53	560	1	1/8	1701 25600	Erie	109 H. S.
R54	1300	1	1	1964 31300	Welwyn	Welmet M. F.
R55	27K	10	1/4	1723 42700	Erie	16 Carbon
R56	100K	10	1/4	1723 51000	Erie	16 Carbon
R57	1000	10	1/4	1723 31000	Erie	16 Carbon
R58	1000	10	1/4	1723 31000	Erie	16 Carbon
R59	24K	1	1/8	1701 42400	Erie	109 H. S.
R60	22	10	1/4	1723 12200	Erie	16 Carbon
R61	22	10	1/4	1723 12200	Erie	16 Carbon
R62	4300	1	1/2	1707 34300	S. T. C.	4304 H. S.
R63	750K	1	3/4	1707 57500	S. T. C.	4304 H. S.
R64	2.7M	1	3/4	1710 62700	Painton	74 H. S.
R65	33K	1	1/8	1701 43300	Erie	109 H. S.
R66	68K	10	1/4	1723 46800	Erie	16 Carbon
R67	100K	10	1/4	1723 51000	Erie	16 Carbon
R68	470K	10	1/4	1723 54700	Erie	16 Carbon
R69	22K	10	1/4	1723 42200	Erie	16 Carbon
R70	1000	10	1/4	1723 31000	Erie	16 Carbon
R71	180K	10	1/4	1723 51800	Erie	16 Carbon
R72	82K	10	1/4	1723 48200	Erie	16 Carbon
R73	1M	10	1/4	1723 61000	Erie	16 Carbon
R74	5100	1	1	1964 35100	Welwyn	Welmet M. F.
R75	330	1	1	1964 23300	Welwyn	Welmet M. F.
R76	220	1	1	1964 22200	Welwyn	Welmet M. F.
R77	22	10	1/4	1723 12200	Erie	16 Carbon
R78	470K	10	1/4	1723 54700	Erie	16 Carbon
R79	6.8M	10	1/4	1723 66800	Erie	16 Carbon
R80	33K	10	1/4	1723 43300	Erie	16 Carbon
R81	330	10	1/4	1723 23300	Erie	16 Carbon
R82	100K	10	1/4	1723 51000	Erie	16 Carbon
R83	56K	10	1/4	1723 45600	Erie	16 Carbon
R84	1M	10	1/4	1723 61000	Erie	16 Carbon
R85	47K	10	1/4	1723 54700	Erie	16 Carbon
R86	1M	10	1/4	1723 61000	Erie	16 Carbon
R87	10K	10	1/4	1723 41000	Erie	16 Carbon
R88	2.2M	10	1/4	1723 62200	Erie	16 Carbon
R89	910K	1	3/4	1710 59100	Painton	74 H. S.
R90	100K	1	1/8	1701 51000	Erie	109 H. S.
R91	6.8M	10	1/4	1723 66800	Erie	16 Carbon
R92	22	10	1/4	1723 12200	Erie	16 Carbon
R93	1000	10	1/4	1723 31000	Erie	16 Carbon
R94	1000	10	1/4	1723 31000	Erie	16 Carbon
R95	47	10	1/2	1725 14700	Erie	8 Carbon
R96	3600	1	1/8	1701 33600	Erie	109 H. S.
R97	3.9M	10	1/4	1723 63900	Erie	16 Carbon
R98	5.6	5	1/2	1708 05600		

Circuit Ref.	Value Ohms	Tol. %	Rating Watts	Solartron Part No.	Manufacturer & Type
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RESISTORS VARIABLE

RV1	5000	10	$\frac{1}{2}$	1100 26090
RV2	100	10	$\frac{1}{2}$	1100 26030
RV3	250	10	$\frac{1}{2}$	1100 26040
RV4	500	10	$\frac{1}{2}$	1100 26050
RV5	250	10	$\frac{1}{2}$	1100 26040
RV6	250	10	$\frac{1}{2}$	1100 26040
RV7	250	10	$\frac{1}{2}$	1100 26040
RV8	250	10	$\frac{1}{2}$	1100 26040
RV9	250	10	$\frac{1}{2}$	1100 26040
RV10	250	10	$\frac{1}{2}$	1100 26040
RV11	250	10	$\frac{1}{2}$	1100 26040
RV12	100K	10	1	1100 32140

Circuit Ref.	Value μ Fd	Tol. %	Rating Volts	Solartron Part No.	Manufacturer & Type
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CAPACITORS

C1	0.5	20	500	2301 55000	T. C. C.	CP91S
C2	4.7pF	0.25pF	750	2400 04700	Erie	Ceramicon P100K
C3	0.02	20	500	2301 42000	T. C. C.	CP34S (Sleeved)
C4	22pF	10	500	2105 12200	Suflex	Polystyrene/500V
C5	33pF	10	500	2105 13300	Suflex	Polystyrene/500V
C6	0.05	20	500	2301 45000	T. C. C.	CP37S (Sleeved)
C7	2	25	250	2351 62000	Hunts	W49 B510P
C8	0.25	25	250	2351 52500	Hunts	W49 B507P
C9	0.25	25	250	2351 52500	Hunts	W49 B507P
C10	0.05	20	350	2300 45000	T. C. C.	CP35N (Sleeved)
C11	0.25	25	350	2352 52500	Hunts	W49 B513
C12	0.1	20	350	2300 51000	T. C. C.	CP37N (Sleeved)
C13	0.1	20	350	2300 51000	T. C. C.	CP37N (Sleeved)
C14	1	25	250	2351 61000	Hunts	W49 B509P
C15	1	25	250	2351 61000	Hunts	W49 B509P
C16	10pF	10	500	2105 11000	Suflex	Polystyrene/500V
C17	0.1	20	350	2300 51000	T. C. C.	CP37N (Sleeved)
C18	0.1	20	350	2300 51000	T. C. C.	CP37N (Sleeved)
C19	0.25	25	250	2351 52500	Hunts	W49 B507P
C20	18pF	$2\frac{1}{2}$	750	2084 00077	Suflex	H. S.
C21	0.05	20	350	2300 45000	T. C. C.	CP35N (Sleeved)
C22	0.25	25	250	2351 52500	Hunts	W49 B507P
C23	0.25	25	250	2351 52500	Hunts	W49 B507P
C24	1	25	250	2351 61000	Hunts	W49 B509P
C25	47pF	10	500	2105 14700	Suflex	Polystyrene/500V
C26	47pF	10	500	2105 14700	Suflex	Polystyrene/500V
C27	47pF	10	500	2105 14700	Suflex	Polystyrene/500V
C28	22pF	10	500	2105 12200	Suflex	Polystyrene/500V
C29	3.5-30pF			2900 20110	T. C. C.	TCK0330
C30	3.5-30pF			2900 20110	T. C. C.	TCK0330
C31	0.0047	10	500	2105 34700	Suflex	Polystyrene/500V
C32	10pF	10	500	2105 11000	Suflex	Polystyrene/500V
C33	3.5-30pF			2900 20110	T. C. C.	TCK0330

Circuit Ref.	Description	Solartron Part No.	Manufacturer & Type	
VALVES				
V1	Pentode	3000 05150	Mullard	EF86
V2	Pentode	3000 05100	Brimar	6BR7
V3	Double Triode	3000 33020	Brimar	12AT7
V4	Double Triode	3000 33020	Brimar	12AT7
V5	Pentode	3000 05020	Mullard	CV138
V6	Double Triode	3000 33020	Brimar	12AT7
V7	Pentode	3000 05020	Mullard	CV138
V8	Pentode	3000 05020	Mullard	CV138
V9	Pentode	3000 05020	Mullard	CV138
V10	Double Triode	3000 33020	Brimar	12AT7
V11	Double Diode	3000 22020	Brimar	6AL5
V12	Double Triode	3000 33020	Brimar	12AT7
V13	Double Triode	3000 33040	Brimar	12AX7

MISCELLANEOUS

F1	Fuse 1A	3601 03080		TDA11
T1	Transformer	3020 00060	Parmeko	
M1	Meter	3400 13030	Sangamo Weston	
SK1	Jack 800 B6 Mk. 1	3525 03010		
SW1	Switch Wafer	3711 03010		
SW2	Switch Wafer	3714 09020		
SW3	Switch Toggle 3A	3760 00030	Painton	501085
SW4	Switch Toggle 3A	3760 00030	Painton	501085
PSU	Power Supply Sub-Unit		Solartron	AS952.2

NOTE: Equivalent components by other manufacturers may be fitted in some instruments.

ABBREVIATIONS:	S. T. C.	Standard Telephones & Cables
	T. C. C.	Telegraph Condenser Company
	G. E. C.	General Electric Company
	W. W.	Wire Wound
	H. S.	High Stability
	M. F.	Metal Film
	Pa.	Paper
	Po.	Polystyrene
	M. P.	Metalised Paper
	M. Pl.	Metalised Plastic
	Ce.	Ceramic
	El.	Electrolytic
	OF	Oxide Film

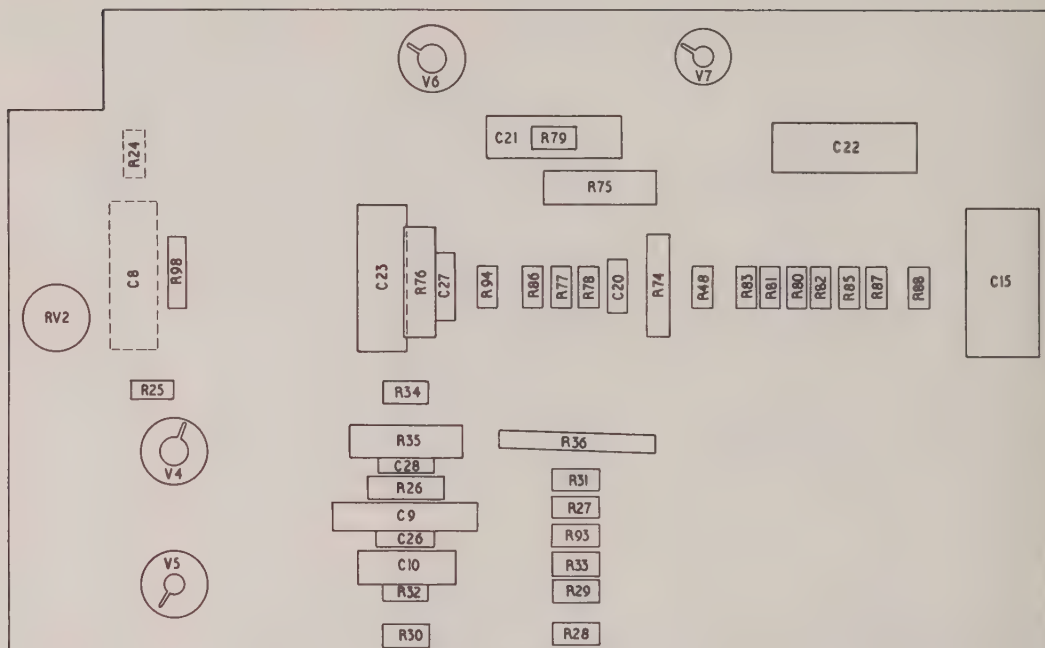


Fig. 5. Bottom chassis : Component layout

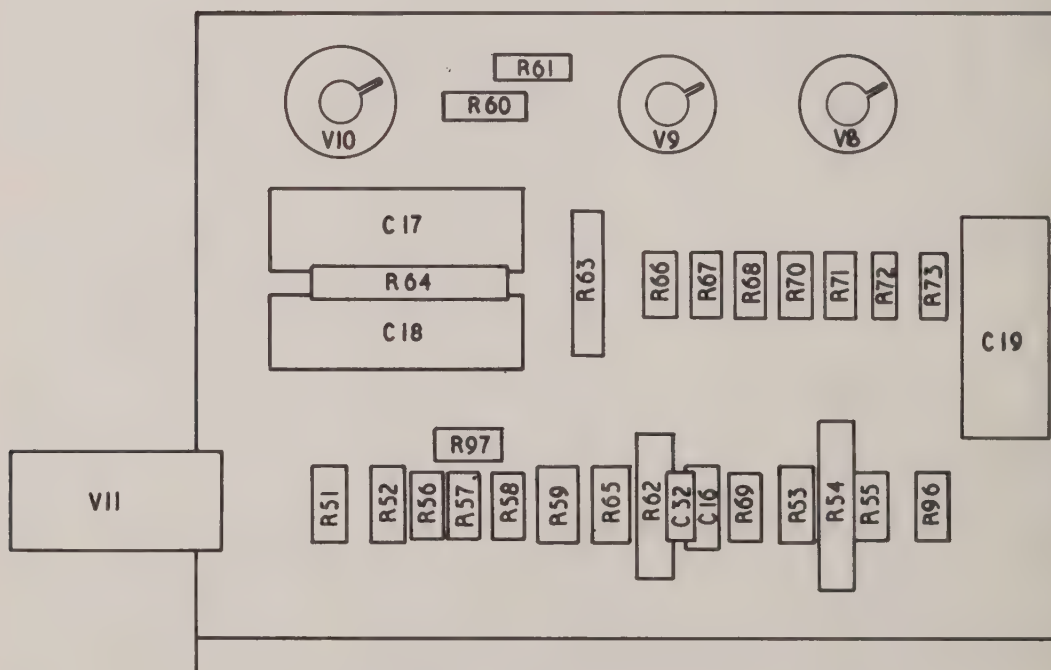


Fig. 6. Right side : Component layout

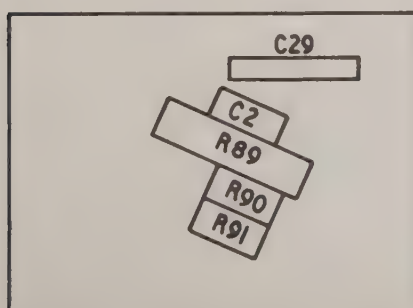
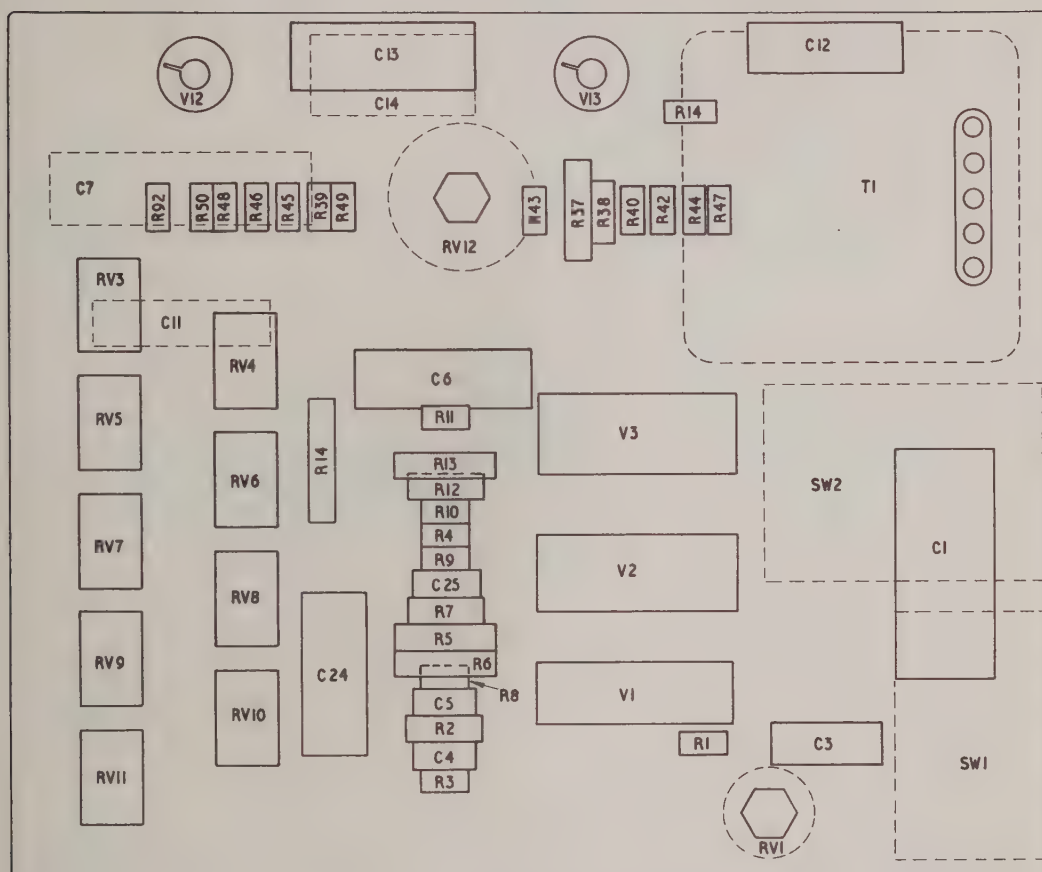


Fig. 8. Switch 1 viewed from rear : Component layout

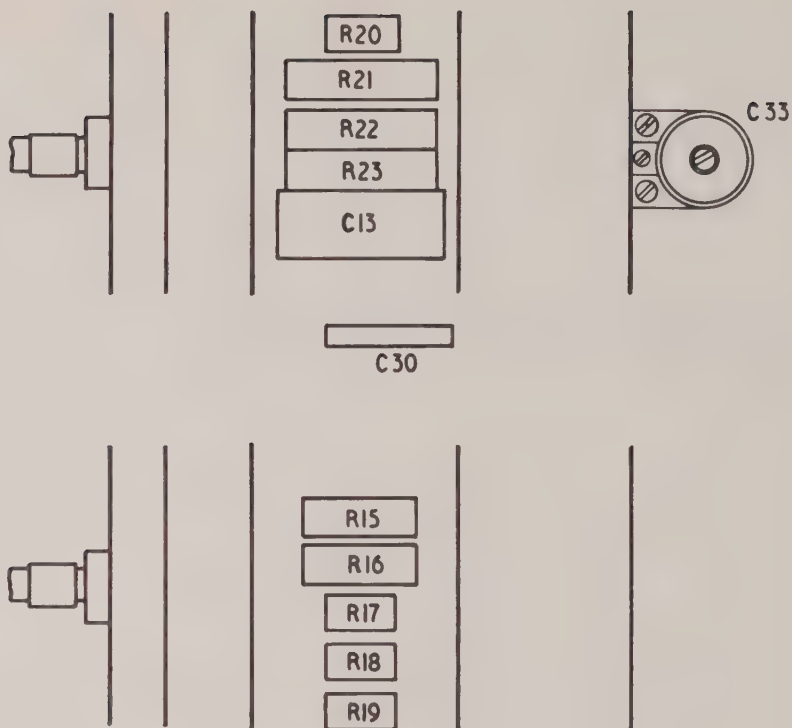


Fig. 9. Switch 2 : Component layout

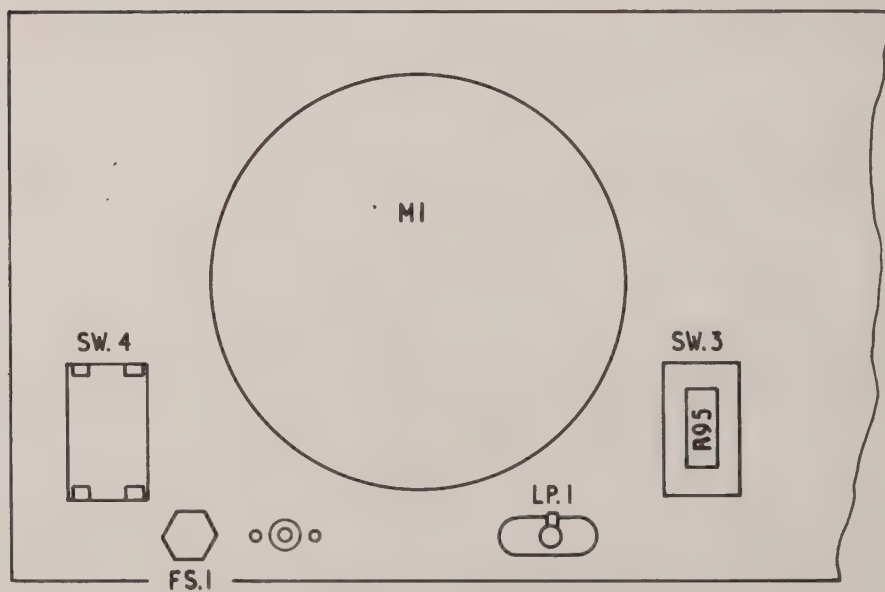
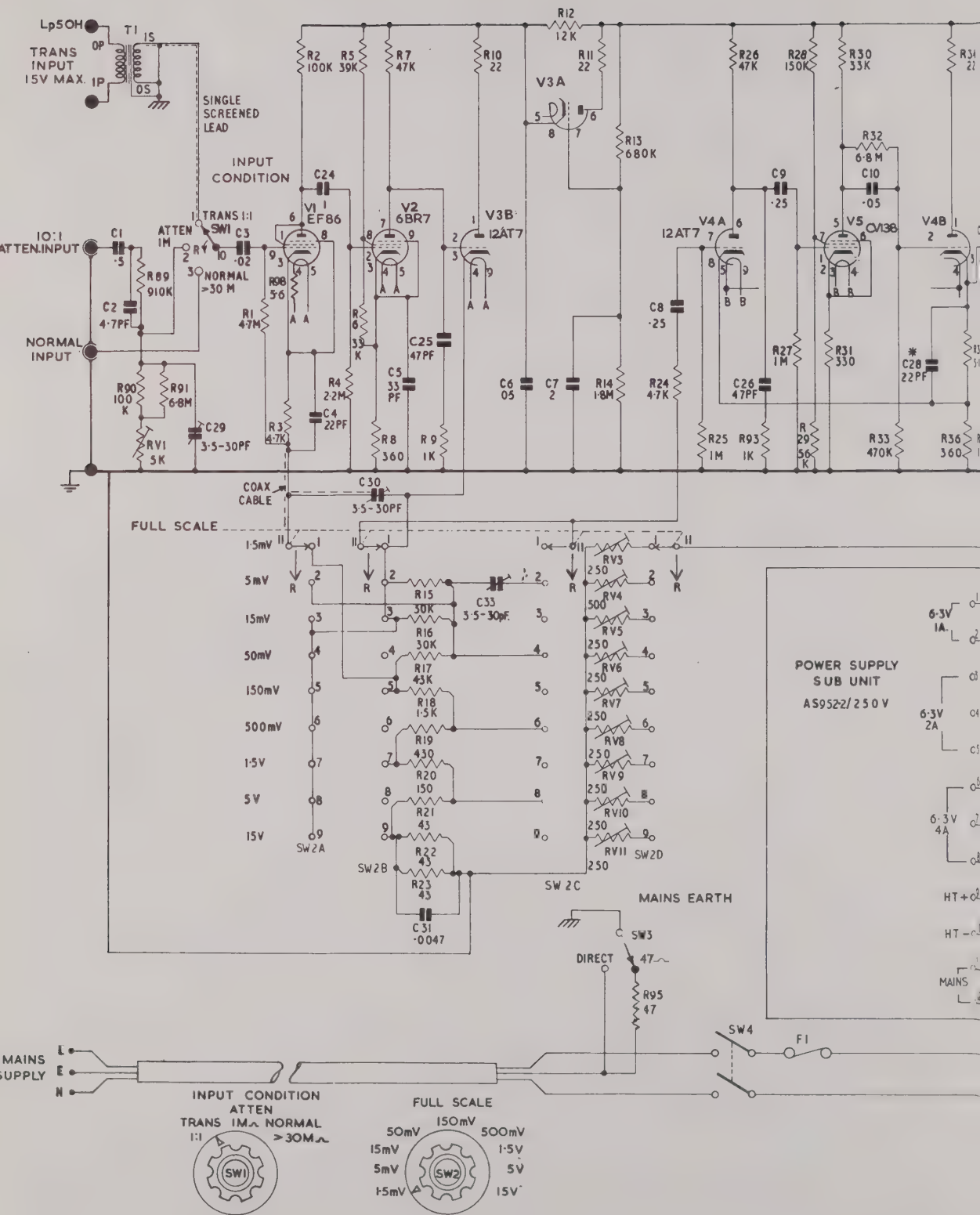
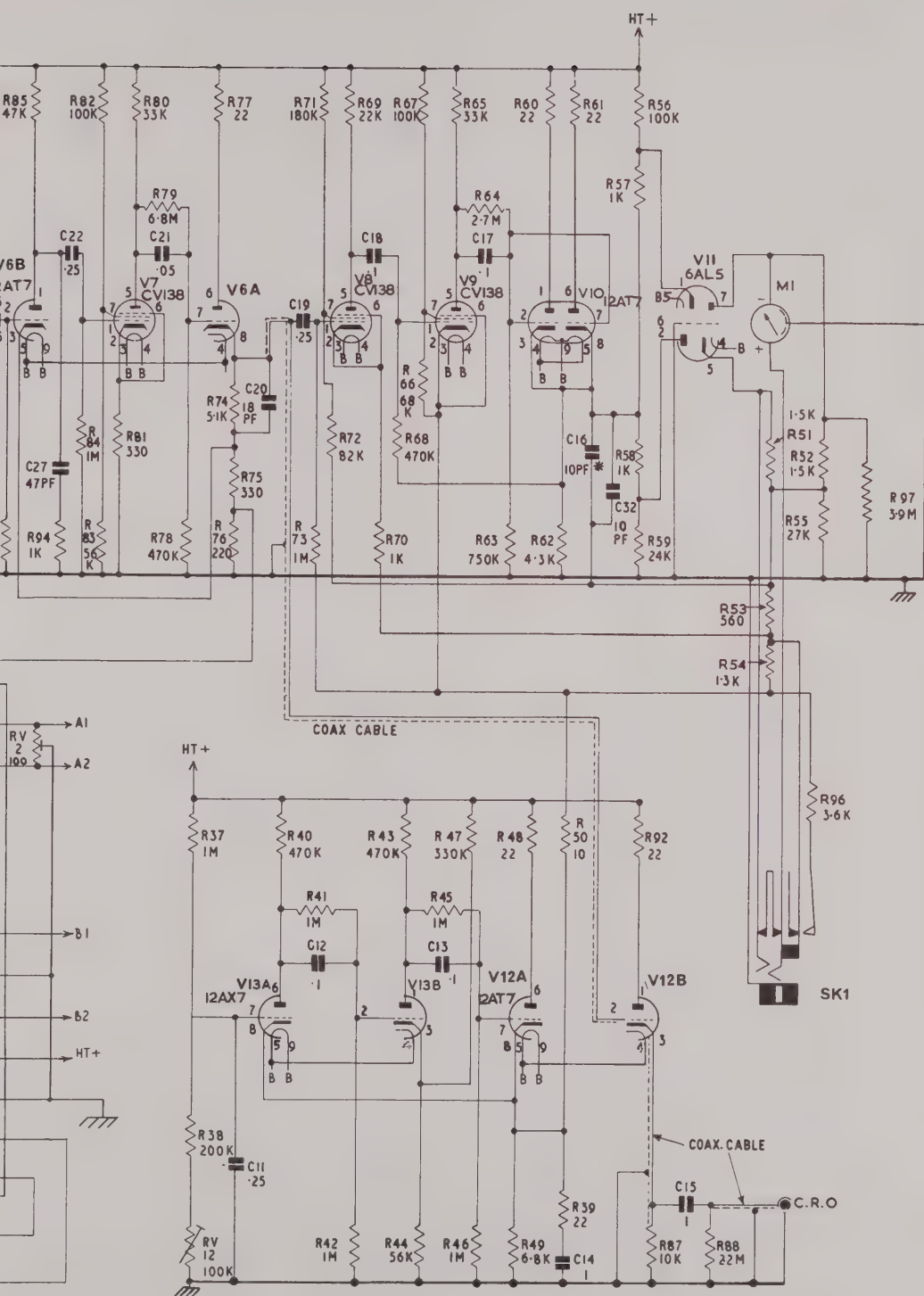


Fig. 10. Rear of front panel : Component layout





NOTE:-

1. CAPACITOR VALUES ARE GIVEN IN MICROFARADS UNLESS OTHERWISE STATED
2. —R— INDICATES DIRECTION OF MOTION FOR CLOCKWISE ROTATION OF CONTROL KNOB.
- * ADJUSTED ON TEST

Fig. 11. The A.C. Millivoltmeter : Circuit diagram

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COPY

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Issue No.	2	2	1	1	1	1	2	1									

DIAGRAMS

Drawing No.	CC952.2					
Fig. No.	3					
Issue No.	4					

SECTION I

INTRODUCTION

This electronically regulated HT Power Supply Sub-Unit has been developed by the Solartron Electronic Group to provide power supply units as components, rather than as bench instruments. Each unit is a carefully engineered entity, ready for immediate inclusion in a research or production instrument. It is also suited to the requirements of educational establishments and radio and television servicing, where the small physical dimensions permit ease of use in congested work areas.

Both HT lines are isolated from earth so that the units may be used to give positive or negative outputs, and may be connected in series. Maximum reliability is ensured, even after long periods in store by the elimination of electrolytic capacitors and by using only the highest quality components. Each unit is mounted on a light, but rigid sub-assembly frame provided with fixing points and angle brackets to permit fixing in any plane.

SECTION II

OPERATING INSTRUCTIONS

Check that the mains tapping panel is correctly set.

Connect the power unit as required, making sure that the chassis is suitably earthed.

A separate connection is provided for the transformer screen, and this should be connected to give the minimum mains-borne noise. Normally the main earth point will prove best.

The output voltage may be adjusted between 200 and 300V by means of the preset potentiometer RV1.

SECTION III

PERFORMANCE SPECIFICATION

DC Output Voltage:	± 200 -300V continuously variable.	Ripple and Noise Content:	$< 2\text{mV}$ peak-to-peak.
DC Output Current:	0-100 mA.	Permissible Supply Deviation:	$\pm 7\%$.
AC Outputs:	6.3V 4A C. T. 6.3V 2A C. T. 6.3V 1A.	Power Input:	100-125V or 200-250V 50c/s - 60c/s or 400c/s
Stability Factor:	400 : 1.	Weight:	13 lbs.
Source Impedance: (dc - 250 kc/s)	$< 0.75\Omega$	Dimensions:	$9\frac{1}{4}" \times 6" \times 5\frac{15}{16}"$ high overall.

SECTION IV

PRINCIPLES OF OPERATION

The circuit used in this power unit is composed of the following sections:-

1. Power Transformer
2. Main Full-Wave Rectifier
3. Auxiliary Full-Wave Rectifier
4. 75V Stabilised Supply
5. Stable Voltage Reference
6. Feedback Network
7. DC Amplifier
8. Series Control Valve

These are connected together as shown in the accompanying block diagram (Fig. 1)

A proportion of any change which appears on the stabilised output is fed through the feedback network into the wideband DC amplifier. It is then amplified and fed to the grid of the series control valve. This alters the volt drop across the series valve in such a sense as to oppose the initial change. The final magnitude of the change is a function of the gain of the wideband DC amplifier. The series valve is pentode connected giving it a high amplification factor. It can thus tolerate large ripple voltages on its anode which eliminates the need for a smoothing choke.

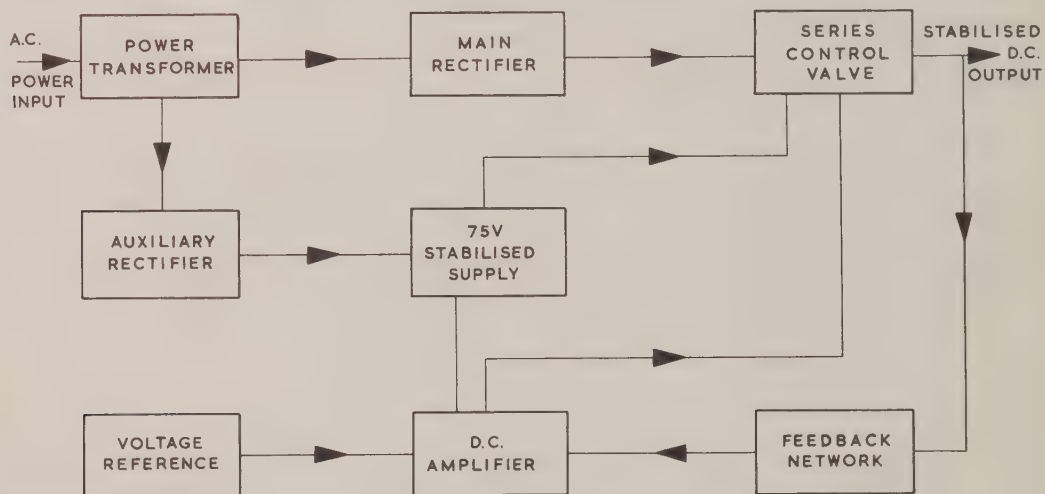


Fig. 1. Block Diagram

SECTION V

CIRCUIT DESCRIPTION

The circuit is described in the eight sections mentioned in the principles of operation.

The power transformer has two primary windings accurately wound for series or parallel operation and tapped to accept supply voltages of 100-125 volts in 5 volt steps, or 200-250 volts in 10 volt steps. Series or parallel operation may be obtained by adjusting the plug tappings on the mains selector panel. Eight secondary windings are provided as follows:-

Main HT: centre-tapped, this provides the main 200-300V power.

Auxiliary: centre-tapped, this feeds the 6X4 auxiliary rectifier valve (V1) for the 75V stabilised supply.

5V 2A: heater supply for GZ34 main rectifier valve (V2).

6.3V 2A: heater supply for 6X4 (V1) and the 12E1 series control valve (V3).

6.3V 1A: heater supply for the two ECF80 DC amplifier valves (V5 and V6).

6.3V 1A: AC output.

6.3V 2A: centre tapped AC output.

6.3V 4A: centre tapped AC output.

The main full-wave rectifier is a GZ34 valve (V2) with its cathode connected direct to a reservoir capacitor C2, and via R19 to the anode of the series control valve(V3).

The auxiliary full-wave rectifier is a 6X4 valve (V1) with its cathode connected direct to reservoir capacitors C1, C7 and C8 and via R3 to the 75V stabiliser.

The 75V stabiliser is a 75C1 neon stabiliser (V4) connected between the positive output of the auxiliary rectifier and the stabiliser HT+ rail, which is common with the auxiliary negative. This source supplies the anodes of the pentode sections of both ECF80 valves (V5B and V6B) and the triode section of V5. The screen of the series control valve (V3) is also supplied via the resistor R20 from this source.

The voltage reference is a Mullard 85A2 operating at a current between 4 and 8 mA according to the output voltage setting. This valve has a burning voltage of 85V.

The feedback network is a series of high stability resistors connected between the stabilised HT+ and HT- lines. It acts as a potential divider supplying an error signal to the wideband DC amplifier.

The DC amplifier consists of two ECF80 triode-pentode valves (V5 and V6). The pentode sections (V5B and V6B) are connected as a cathode coupled differential amplifier, and the triode sections (V5A and V6A) are similarly connected to form the second stage. The first stage of the amplifier compares the reference voltage with a portion of the HT voltage. The reference voltage developed across V7 is filtered by R15 and C5 against noise. The signal is taken from the HT line, through the feedback network to the grid of V6B, and C4 is added to increase the coupling for ripple and noise. Under operating conditions the grid of V6B must always be at virtually the same potential as the grid of V5B. Thus as the wiper of RV1 is moved, the HT potential must vary to maintain balanced conditions. The push-pull output from this stage is directly coupled to the second stage, where further amplification takes place. The output from one side of the second stage (V5A) is fed via the stopper R4 to the grid of the series control valve. First order correction of DC drifts due to heater fluctuations is obtained from the balancing action of the differential amplifiers. The heaters of both ECF80 valves are returned to a DC potential derived from the V5A and V6A cathode resistor network R6 and R7.

The series control valve (V3) carries the current drawn from the stabilised HT rail. The screen of this 12E1 valve is fed from the 75V stabilised supply via R20, and a control voltage from the DC amplifier is applied to the grid. C6 is connected across the HT output and a 0.3 ohm resistor R17 is placed in series with the HT+ output to obviate unwanted phase shifts when the supply is applied to inductive or capacitive loads.

SECTION VI

SERVICING INFORMATION

Performance Tests

Supply the unit with nominal mains and correctly load all the AC and DC outputs. The voltage at the AC outlets should be $\pm 3\%$ of nominal. The DC potential can be accurately set by adjusting RV1.

Monitor the DC stabilised line with a CRO and check that the hum and noise present on the DC output is less than that specified. The chassis and transformer screen should be earthed for this test.

Check that the changes of DC output are not measurable when the HT current is changed from the full load to zero and when the mains input is varied $\pm 7\%$ about normal.

The AC source impedance may be measured by driving 5 mA AC into the stabilised output through a suitable capacitor and a 1 k Ω resistor, and measuring the AC potential across the output.

Quiescent Potentials

These potentials are supplied for information only and are not mandatory requirements. They were measured using an Avo Model 8 and are taken at full load current with the output set to 250V and the supply adjusted to match the nominal voltage. All readings are measured with respect to the 0V line.

TABLE

Test Point	Meter Range	Reading
V1 Cathode (Pin 7)	1000V	+433V
V4 Pin 1	1000V	+320V
V2 Cathode (Pin 8)	1000V	+475V
V5A Anode (Pin 1)	500V	+250V
V5A Cathode (Pin 8)	250V	+180V
V5B Cathode (Pin 7)	250V	+87V
V6B Anode (Pin 6)	250V	+180V
V5B Anode (Pin 6)	250V	+180V

SECTION VII

COMPONENTS LIST

Circuit Ref.	Value Ohms	Tol. %	Rating Watts	Solartron Part No.	Manufacturer & Type	
RESISTORS						
R1	Not fitted					
R2	Not fitted					
R3	3900	5	4½	238732	Painton	P301A W.W.
R4	100	10	¼	226313	Erie	16 Carbon
R5	47k	10	½	226545	Erie	8 Carbon
R6	12k	5	2	235638	Welwyn	F32 M.F.
R7	22k	5	2	235641	Welwyn	F5 M.F.
R8	36k	2	½	223879	Painton	74 H.S.
R9	30k	2	½	223877	Painton	74 H.S.
R10	Not fitted					
R11	300k	2	½	223901	S. T. C.	4304 H.S.
R12	Not fitted					
R13	68k	2	½	223886	Painton	74 H.S.
R14	300k	2	½	223901	S. T. C.	4304 H.S.
R15	33k	10	¼	226343	Erie	16 Carbon
R16	15K	5	2	235639	Painton	P306A W.W.
R17	0.33			N22600	Painton	MV1A W.W.
R18	12K	5	2	235638	Painton	P301A W.W.
R19	10	10	¼	226301	Erie	16 Carbon
R20	47	10	¼	226309	Erie	16 Carbon
RV1	50k	10	½	N25071	Colvern	CLR4201/9S W.W.
CAPACITORS						
Circuit Ref.	Value µFd	Tol. %	Rating Volts	Solartron Part No.	Manufacturer & Type	

CAPACITORS

C1	2	20	250	N20345	Hunts	AM106M. Pl.
C2	8	20	600	211204	T.C.C.	CP150T Pa.
C3	0.1	20	250	N20236	Hunts	AM102M. Pl.
C4	0.25	20	250	N20235	Hunts	AM103M. Pl.
C5	0.1	20	250	N20236	Hunts	AM102M. Pl.
C6	8	20	600	211204	T.C.C.	CP150T Pa.
C7	2	20	250	N20345	Hunts	AM106M. Pl.
C8	2	20	250	N20345	Hunts	AM106M. Pl.

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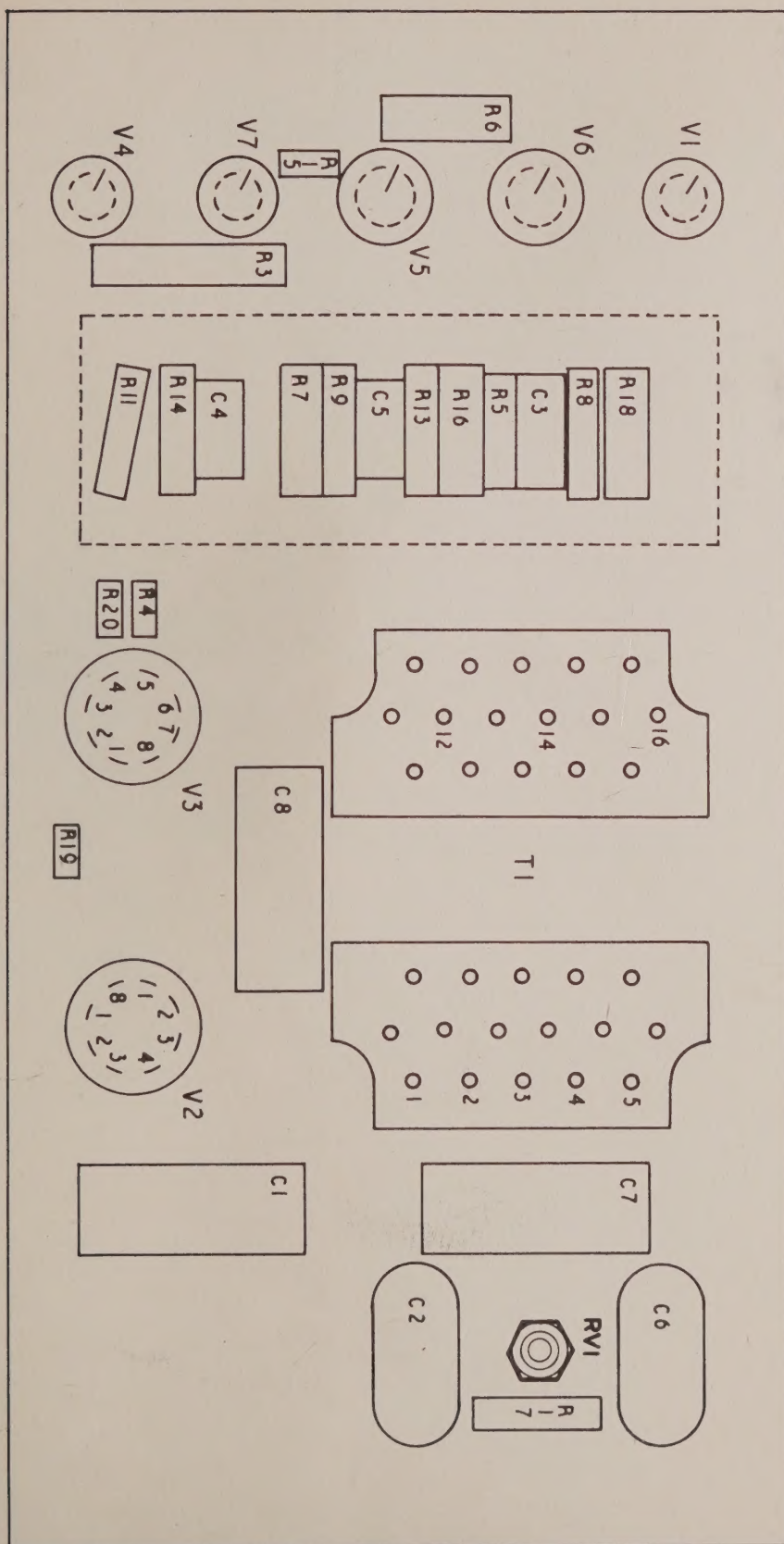
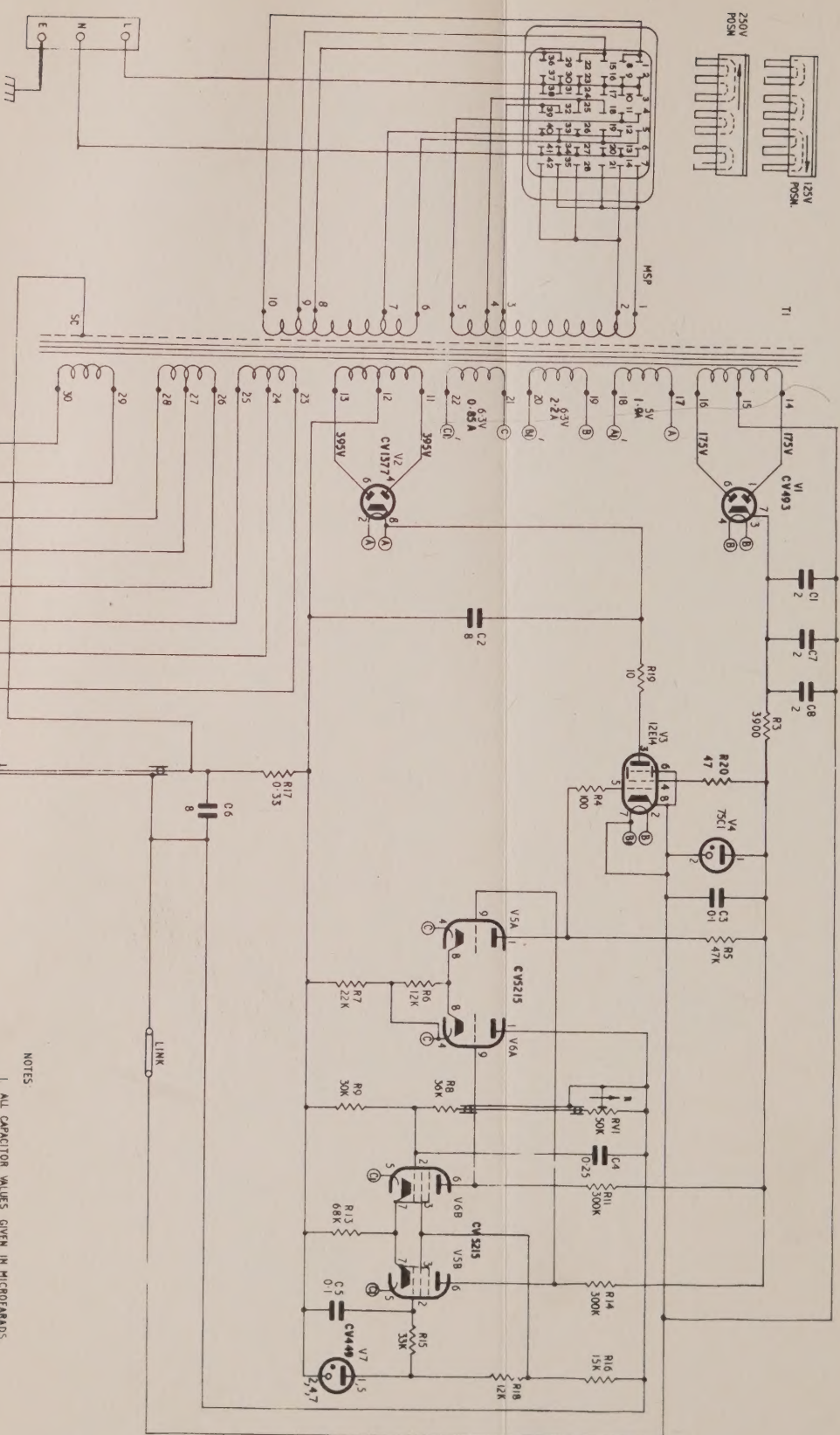


Fig. 2. Component Layout Diagram.

R		R19	R3	R20	R4	R5	R6	R8	R9	R11	R13	R14	R15	R16
C		C1	C2	C7	C8	C3	C4	C5						
MISC.	MSP	T1	V1	V2	V3	V4	V5A	V6A	V6B	V7				



NOTES
 1 ALL CAPACITOR VALUES GIVEN IN MICROFARADS
 2 R → INDICATES CLOCKWISE ROTATION

Fig. 3. Circuit Diagram AS 952.2.

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